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MICROTUBER FOR POTATO PRODUCTION: INFLUENCE OF SIZE AND SPACING

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Abstract

Microtubers of three different sizes (<150 mg, 150-300 mg and >300 mg) were evaluated with four different spacings (60X10 cm, 60X15cm, 60X20cm and 60X25cm) in the experimental field of Horticulture department of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh to find out the optimum spacings for different graded microtubers. The maximum foliage coverage, plant height, stems/hill, number of tuber/plant, number of tuber/m^2 and tuber yield were found with large size microtuber. Closest spacing showed highest foliage coverage, number of tuber/m^2 and yield per unit area but tuber number/plant and tuber yield/plant were the highest with widest spacing. Closest spacing produced higher percentage of under size tuber whereas widest spacing produced maximum percentage of oversize tuber. The highest yield (33.3 t/ha) with maximum percentage of seed size tuber was produced by large microtubers with 60 cm x 15 cm spacing. Higher percentage of seed size tuber with good yield (26.6 t/ha) was also showed by medium size (150-300 mg) microtuber with 60 cm x 15 cm spacing. Small size (<150 mg) microtubers also produced good yield (17.6 t/ha) with 60 cm x 10 cm spacing.

Key words: Microtuber size, spacings, potato yield

Introduction

In vitro propagation of potato by serial culture of axillary buds in separated nodes is commonly used in disease free seed production, germplasm exchange and conservation (Dodds *et al.* 1991, Ranalli *et al.* 1994). In vitro propagated plantlets cultured under suitable conditions produce microtubers (Wang and Hu 1982, Hussey and Stacey 1984) which are usually 2 to 10 mm diameter and originate as aerial structures from the micro stems, although a few may also be formed in the medium.

Microtubers are particularly convenient for handling, storage and transport of germplasm, and for material free of plant pathogens specially plant viruses (Hussey and Stacey 1984). They need to be multiplied at least once and preferably two or three times under protected or field conditions to reduce the costs of production of seed potatoes (Van der Zaag 1991) or for other uses. The future use of microtubers will depend on their yielding ability under field conditions. Microtubers yielded less than minitubers and normal tubers because of the large number of small tubers in their progeny. This could be improved by preplanting the microtubers in pots in the greenhouse before transplanting to the field and might lead to earliest and larger foliage ground cover and perhaps to more tubers per plant (Haverkort and Marinus 1990). Closer planting as well as larger tuberlets (produced from true potato seed) increased tuber yield significantly (Rashid *et al.* 1993). The greater sizes of the microtubers of cv. Morene resulted in more stems and more tubers per plant and a greater tuber yield per plant reported by Haverkort *et al.* (1991). The distance between rows significantly affected the performance of microtubers. At close row spacing, microtubers yielded more than at wide spacing (Ranalli 1997). Yields from small seed tubers might be improved by increasing sprout or stem density or by reducing the spacing between rows. Closer spacing within rows is probably more effective in increasing yield, but information is lacking. Therefore the study was undertaken to evaluate different sizes of microtubers in combination with different spacings in the field for increasing yield of potato.

Materials and Method

Eight stem segments (each with 3 nodes) of sub cultured in vitro plantlets were transferred into 250 ml Erlenmeyer flasks containing 40 ml tuber induction MS (Murashige and Skoog 1962) medium supplemented with 10 mg/l BA and 9% sucrose. The cultures were kept at 20°C in continuous dark. The induced microtubers were harvested aseptically after 70 days of incubation period. Harvested microtubers were washed with sterile water to remove media from their surface and soaked with fungicide solution very quickly which were then dried in the clean bench by blowing clean air. Air dried clean microtubers of Diamant was separated into three grades, viz. <150 mg, 150-300 mg and >300 mg. After a curing period of 15 days at 12 C, they were stored in refrigerator at 3°C temperatures. After one and half month these were kept at 14°C for 1 week and then these microtubers were placed in a well ventilated room for sprouting. Before 20 days of planting, sprouted microtubers were first placed in poly bags having a mixture of cow dung and loamy soil at the ratio of 1:1. These poly bags were kept in net house. When the plantlets were about 10cm height they were placed outside for 2 days to harden prior to transplanting to the field. Preplanting of microtubers in pots before transplanting to the field was done for earlier and larger foliage ground cover and perhaps to more tubers per plant (Haverkort and Marinus 1990). The prepared seedlings from three grades (<150 mg, 150-300 mg and >300 mg) of microtubers transplanted in the field with four different spacings (60X10 cm, 60X15cm, 60X20cm and 60X25cm) which in combination made 12 treatment combinations. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Full doses of cow dung (10 tha^{-1}), TSP (220 kgha^{-1}), MP (270 kgha^{-1}), Gypsumm (120 kgha^{-1}), ZnSO4 (14 kgha^{-1}), Boric acid (6 kgha^{-1}) half doses of Urea (175 kgha^{-1}) were applied at final land preparation. The rest half doses of urea were applied as top dressing in two splits for proper growth of the crops. Intercultural operations such as weeding, irrigation and earthing up were done manually as per need. Earthing up was done in 3 times during growing period at 30 days, 50 and 70 days after planting respectively. Before earthing up, urea was applied. Irrigation was applied four times, first one was two weeks after planting, second one was just after earthing up, third one was at 55 days and the last one was at 75 days after planting. During land preparation, Miral (0.30%) was applied to soil for the control of soil insects. A general dose of 0.2% Asataf (Systemic insecticide) was sprayed at every 15 days and Dithane M-45 @ 0.2% was sprayed at 10 days interval. The spraying was started at 35 DAP. The collected data were analyzed with the help of computer using MSTAT-5 program and the mean separation was done by Duncan's new multiple range test.

Results and Discussion

Effect of size of microtuber

Plant stand at 45 days after planting (DAP) was the highest with large size (>300mg) microtubers (95.8%) followed by medium (150-300mg) and small size (<150mg) microtubers (Table

Table 1. Effect of microtuber size on the field performance of potato crop raised from microtuber

Treatment Size (mg)	Plant stand at 45 DAP (%)	Foliage coverage (%) at 75 DAP	Plant height (cm)	Main stems/ plant	No. of Tuber/ Plant	No. of tuber/m^2	Yield/ Plant (g)	Yield (t/ha)	Grade of tubers by weight (%)		
									<20g	<20-40g	<40g
<150	79.0 c	79.0 c	56.0 b	1.1 b	7.5 c	61.8 c	154.4 c	12.6 c	40.6	51.2	8.2
150-300	90.6 b	92.5 b	74.5 a	1.3 ab	10.0 b	94.3 b	267.5 b	23.9 b	24.0	60.4	15.6
>300	95.8 a	95.0 a	78.7 a	1.5 a	11.6 a	112.4 a	317.9 a	29.7 a	20.9	60.8	18.3
Level of significance	**	**	*	*	*	**	*	**	NA	NA	NA
CV (%)	6.5	7.6	8.2	6.3	6.1	10.1	9.8	8.6			

Means bearing same letter (s) do not differ significantly at 1 or 5% level of probability
NA- Not analyzed
*-Significant at 5% level of probability
**- Significant at 1% level of probability

1). The maximum survivability of plants produced from large size microtubers may be due to strong sprouts as well as vigorous seedlings with large microtubers. Foliage coverage was the maximum with large size microtubers (95.0%) followed by medium and small size microtubers. The maximum foliage coverage might be due to the presence of large plant population as well as more number of stems with large microtubers. Foliage coverage decreased with decrease in size of mother tuber reported by Ranalli *et al.* (1994) which corroborate the present findings. The tallest plant (78.7 cm) was with large size microtubers which was statistically similar to medium size, while it was shortest with small size microtubers. The tallest plant with large size microtubers was probably due to the presence of more reserve food in large tuber which causes rapid growth of plants at earlier stage. The number of main stems per plant increased significantly with increase in the size of microtubers. Higher stems/plant with large microtubers was reported by Haverkort *et al.* (1991). The increased number of main stems per plant in the large size microtubers may be due to higher number of eyes (Siddique *et al.*, 1987). Large size microtuber produced 11.6 tubers per plant compared to 7.5 tubers produced by small microtubers. Similar trend was also observed in number tubers/m^2. The results were in agreement with the reports of Haverkort *et al.* (1991) who found increasing number of tuber/plant with increase in size of microtuber. In the present study, an increase in the number of tuber per plant with increase in the number of main stems was noticed (Table 1). Similar relationship between the above two parameters was also observed in normal tuber by Escribeno, 1962 and Siddique *et al.*, 1987. The yield of tubers per plant increased significantly with increase in the size of microtuber. The maximum yield of tubers per plant (317.9g) was obtained from large size microtubers and the minimum (154.4g) from small size microtuber. The findings were in agreement with that of Haverkort *et al.* (1991) who reported increasing tuber yield per plant with increase in size of microtuber. The higher yield of tubers per plant with large size microtuber was associated with increased vegetative growth of plants and higher number of tubers per plant. Per hectare yield was also increased significantly with increase in size of microtuber (Table 1). The large microtuber (>300g) produced 29.7 tons of potato per hectare compared to 12.6 tons produced by the smallest (<150mg) microtubers. Higher yield (t/ha) with large tubers were reported in normal seed tubers by Sultana 1990. The large size microtubers produced the highest percentage (18.3) of large tuber (>40g), while small size microtuber produced the highest percentage (40.6) of small tuber (Table 1). Large and medium sized microtuber produced higher percentage (>60%) of seed size (20-40g) tuber.

Effect of spacings

There were no significant influence of spacings on plant stand at 45 DAP, plant height and main stems/plant although they varied (87.8 to 89.1%), (68.7 to 70.8 cm) and (1.2 to 1.3) respectively (Table 2). Foliage coverage increased with reducing plant spacings. The highest foliage coverage (96.7%) observed with closest spacings (60 cm x 10cm), while it was lowest with widest spacings (60 cm x 25cm). The result was in agreement with that of Ranalli *et al.* (1994) who found higher foliage coverage with closer spacings compared to wider spacing. The number of tubers per plant increased with the increase in plant spacing (Table 2). The highest number of tubers per plant (10.3) was obtained with widest spacing (60 cm x 25cm) while the lowest number (8.4) was obtained from the narrowest spacing (60 cm x 10cm). The increase in number of tubers per hill in wider spacing was probably due to less inter-plant competition for space, light, water and nutrient. The present

Table 2. Effect of spacings on the field performance of potato crop raised from microtuber

Treatment Size (mg)	Plant stand at 45 DAP (%)	Foliage coverage (%) at 75 DAP	Plant height (cm)	Main stems/ plant	No. of Tuber/ Plant	No. of tuber/m^2	Yield/ Plant (g)	Yield (t/ha)	Grade of tubers by weight (%)		
									<20g	20-40g	<40g
60 x 10	88.2	96.7 a	70.8	1.2	8.4 b	122.2 a	165.4 d	24.6 a	45.5	46.8	7.7
60 x 15	87.8	93.3 b	68.9	1.3	9.8 a	97.4 b	240.2 c	24.0 a	23.5	62.0	14.5
60 x 20	88.4	86.2 c	70.4	1.3	10.2 a	76.7 c	286.7 b	21.6 b	23.2	61.5	15.0
60 x 25	89.1	80.1 d	68.7	1.3	10.3 a	61.7 d	293.9 a	17.9 c	21.8	60.6	17.6
Level of significance		NS	**	NS	NS	**	*	*	*	NA	NA
NA											
CV (%)	6.5	7.6	8.2	6.3	6.1	10.1	9.8	8.6			

Means bearing same letter (s) do not differ significantly at 1 or 5% level of probability
NA- Not analyzed
NS- Non significant
*-Significant at 5% level of probability
**- Significant at 1% level of probability

finding on the number of tubers per plant as influenced by plant spacing was in agreement with the findings of Svensson (1972), Taleb *et al.* (1973) and Sultana (1990). The number of tuber per square meter was significantly increased with reducing plant spacings (Table 2). The highest number of tubers/m^2 (122.2) produced with closest spacing, while it was lowest (61.7) with widest spacing. This increase in number of tubers/m^2 may be due to increase in number of stems per unit area with increase in plant population as tuber number has been related to stem number as reported by Bremner and Radely (1966) and Bremner. Singh *et al.* (1997) reported that tuber number/m2 increased with the increase in plant density which corroborates the present findings. The highest tuber yield/plant (293.9g) produced with widest spacings and minimum tuber yield per plant (165.4g) was found with closest spacings. Tuber yield per plant increased with wider spacings were reported by Ellisseche and Pereunce (1977). The yield (t/ha) decreased with increasing plant spacing (Table 2). The highest per hectare yield (24.6 tons) produced with closest spacing (60 cm x 10 cm) which was statistically similar to 60 x 15 cm. The lowest yield (17.9 tons) was obtained from widest spacing (60 cm x 25 cm). Ranalli *et al.* (1994) reported higher yield at closer spacing compared to wider spacing which was in agreement with the present result. Foliage coverage increased with increase in plant density. Since foliage coverage have found to be related to total tuber yield (Bremner and Radley, 1966) therefore, total tuber yield in the present study increased with closest spacing. Percentage of seed size (20-40g) tubers increased with reducing plant spacing upto 60 x 15 cm and reduced with further increase in plant population. The availability of assimilates for individual tuber to grow was less due to increased number of tubers per unit area with closer spacings, which resulted an increase in the yield of seed size (20-40g) and under size tubers. The yield of over size tubers decreased with closer spacing. The over size tubers decreased with closer spacings were reported by Wurr *et al.* (1992) and Singh *et al.* (1997) which support the present findings.

Interaction effect of spacing and microtuber size

The highest percentage (96.6) of plant stand at 45 DAP with large microtubers planted at the widest spacings, and it was lowest (79.7) with small microtubers planted at closest spacing. Hundred percent foliage coverage was found with medium to large sized microtubers planted at 60 cm x 10 cm and large microtubers planted at 60 cm x 15 cm spacings (Table 3). The lowest percentage of foliage coverage (66.2) found with small microtubers planted at widest spacing. The tallest plant (80.4cm) produced with large microtuber planted at closest spacing. This highest plant height at closest spacing may be due to greatest competition between stems for light. Jagroop *et al.* (1993) and Singh *et al.* (1997) observed taller plants with large size normal seed tubers planted at closer spacings. The highest number of stems and tuber per plant were observed with large microtuber (>300mg) planted at widest spacing. The large microtubers planted at closest spacing produced maximum number of tubers/m^2 (146.6) while the minimum number of tuebrs/m^2 produced with small microtubers planted at widest spacing. The highest tuber yield per plant (385.0g) found with large microtubers planted at widest spacings (60 cm x 25 cm). But the large microtuber planted at 60 cm x 15cm spacing was found to give the highest yield (t/ha) of tubers (33.3t/ha) followed by the same size microtuber planted at 60 cm x 10 cm spacing. The highest percentage (49.0) of under size (<20g) tubers produced with small microtubers planted at 60 x 10 cm spacing. The maximum percentage (66.6) of seed size (20 - 40g) tubers found with large microtuber planted at

Table 3. Interaction effect of microtuber size and plant spacings on the field performance and yield of potato crop raised from microtuber

Treatment Combination Spacings (cm)	x Size (mg)	Plant stand at 45 DAP (%)	Foliage coverage (%) at 75 DAP	Plant height (cm)	Main stems/ per plant	No. of Tuber/ Plant	No. of tuber/m^2	Yield/ Plant (g)	Yield (t/ha)	Grade of tubers by weight (%)		
										<20g	20-40g	<40g
60x10	<150	79.7 d	90.0 c	56.8 c	1.0 c	6.8 d	90.3 d	132.4 f	17.6 g	49.0	44.7	6.3
	150-300	89.4 c	100.0 a	75.1 ab	1.2 abc	8.7 bcd	129.6 b	170.4 e	25.4 d	44.1	47.7	8.2
	>300	95.6 ab	100.0 a	80.4 a	1.4 abc	9.1 abc	146.6 a	193.3 d	30.8 b	42.4	49.1	8.5
60x15	< 150	77.6 d	84.5 d	55.5 c	1.1 bc	7.4 cd	63.8 f	141.4 f	12.2 h	39.3	52.7	8.0
	150-300	91.2 abc	95.4 b	73.1 b	1.3 abc	10.1 abc	102.3 c	262.5 c	26.6 c	17.1	66.3	16.6
	>300	94.6 abc	100.0 a	78.0 ab	1.6 a	12.0 a	126.1 b	316.8 b	33.3 a	14.1	66.6	19.3
60x20	< 150	78.7 d	75.1 e	57.3 c	1.1 bc	7.7 cd	51.8 g	167.7 e	11.0 i	38.1	52.2	9.7
	150-300	91.1 abc	90.1 c	75.3 ab	1.4 abc	10.6 ab	80.5 e	316.1 b	24.0 e	18.6	63.3	18.1
	>300	95.3 ab	93.3 bc	78.7 ab	1.5 ab	12.3 a	97.7 c	376.4 a	29.9 b	13.0	64.1	22.9
60x25	< 150	80.1 d	66.2 f	54.2 c	1.1 bc	7.7 cd	41.1 h	176.0 e	9.4 j	36.1	54.2	9.7
	150-300	90.7 bc	84.5 d	74.4 ab	1.3 abc	10.7 ab	64.7 f	320.8 b	19.4 f	16.2	62.2	21.6
	>300	96.6 a	89.7 c	77.6 ab	1.6 a	12.5 a	79.2 e	385.0 a	24.8 e	14.2	62.4	23.4
Level of significance		**	*	*	*	*	*	*	*	NA	NA	NA
CV (%)		6.5	7.6	8.2	6.3	6.1	10.1	9.8	8.6			

Means bearing same letter (s) do not differ significantly at 1 or 5% level of probability
NA- Not analyzed
*-Significant at 5% level of probability
**- Significant at 1% level of probability

60 cm x 15 cm spacing followed by medium size microtuber planted at same spacing. Higher percentage of seed size tuber with good yield (26.6 t/ha) was also showed by medium size (150-300 mg) microtuber with 60 cm x 15 cm spacing. Small size (<150 mg) microtubers also produced good yield (17.6 t/ha) with 60 cm x 10 cm spacing. Large size microtubers (>300mg) with 60cm X 15cm spacings is suggested for obtaining higher yield of potato.

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